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SUSTAINABLE DEVELOPMENT OF REGIONAL INFRASTRUCTURE SYSTEMS IN THE FACE of CLIMATE CHANGE

Abstract:
The functioning and sustainable development of infrastructure systems in the face of climate change are discussed. The review of foreign approaches to work systems in terms of adverse climatic factors is presented. The regional systems of water supply and sewage systems and their readiness to work in conditions associated with climate change are considered. The problems and obstacles of development for systems were identified. The use of innovative technologies, training staff and improving the quality of management

decisions were proposed as directions of improvement of system of water supply and sewage systems.

Keywords:
sustainable development, climate change, infrastructure, regional system, water supply and sewage systems, water pollution, innovative technologies, human resources management

In recent decades, the term «sustainable development» has become widely used as the designation of one of the possible directions of the future path of human development. In foreign practice, the term «sustainable development» is most often used. The very notion of stability has found application for the survival of mankind in its environment. The concept of sustainability was put forward in the report of the World Commission on Environment and Development of the United Nations (WCED, Commission under the leadership of G.Kh. Brundtland) in 1987 as follows: «sustainable development - development that meets the needs of the present without compromising the ability of future generations to meet their own needs [1]».

However, this treatment of the term is criticized by some scientists. For example, in [2] academician N.N. Moiseev noted: «The «sustainable development» is difficult to translate into Russian ... In Russia this expression was translated as «sustainable development». Such a translation of the term «sustainable development» seems to me a kind of linguistic nonsense, sustainable development simply cannot be – if there is development, then stability is no longer there!». Moiseev says: «I think that now it is no longer appropriate to abandon the phrase «sustainable development» – we have become accustomed to it. But the term itself should be have a meaning that meets the scientific content of the problem and the real needs of society».

After the report of the WCED, the main goals of sustainable development were formulated and refined in a number of international documents and programs developed under the auspices of the United Nations.

The past years have shown that the term «sustainable development» has indeed entered into everyday practice, among both politicians and scientists. In the first sence, most authors understand it as the rational coexistence between humans and their habitat.

Thus, in our opinion, when using the term «sustainable development» in relation to infrastructure systems (electrical, thermal systems, water supply and sewage systems, etc.), it is necessary to use the ideas above about the joint development of mankind as a whole and the environment. These systems must constantly evolve under the influence of external forces, including environmental factors such as climate change.

The issue of climate change began to worry the world long ago. The first world meeting on this issue was held in 1979, and the Intergovernmental Panel on Climate Change met for the first time under the auspices of the United Nations in 1988.

The Resolution adopted by the UN General Assembly on September 25 2015, noted [3] that «Climate change is one of the greatest challenges of our time and its adverse impacts undermine the ability of all countries to achieve sustainable development».

Are such changes already taking place, and are they of vital importance for the progress of mankind in the 21st century? After all, many other political, economic, social and environmental issues also require immediate attention.

The analysis shows the existence of a sufficiently large number of scientific data and expert opinions which confirm that climate change is a serious problem and affects every person on Earth.

Thus, in work [4], it is noted that «Earth's 2016 surface temperatures were the warmest since modern recordkeeping began in 1880, according to independent analyses by NASA and the National Oceanic and Atmospheric Administration (NOAA).

Globally-averaged temperatures in 2016 were 1.78 degrees Fahrenheit (0.99 degrees Celsius) warmer than the mid-20th century mean. This makes 2016 the third year in a row to set a new record for global average surface temperatures. The 2016 temperatures continue a long-term warming trend, according to analyses by scientists at NASA's Goddard Institute for Space Studies (GISS) in New York. NOAA scientists concur with the finding that 2016 was the warmest year on record based on separate, independent analyses of the data».

It is shown [5] that «Climate change is a major driver for increasing pressure on water resources, which will possibly aggravate the effects of other water stressors and alter the reliability of current water management systems and infrastructure».

It is emphasized [6] that «Climate change and sustainable development are the central challenges of our time. They are inseparably linked and need to be addressed together. Action to reduce greenhouse gas (GHG) emissions and adapt to climate impacts is essential for ensuring sustainable development».

It is noted [7] that «by raising the levels of warming above pre-industrial levels, a high impact on the food production, water resources, and ecosystems, in addition to posing a moderate high-risk to human and natural systems».

In work [8] it is said that according to some energy companies, «climate change will lead to physical damages to power plants, resulting in reduction or interruption of power production».

It is stated [9] that the indirect effect of climate change «manifests itself in the deterioration of the living conditions of the population, in particular, the destruction of houses as a result of the erosion of coastal areas, the shortage of drinking water, the deterioration of roads, which alters the infrastructure of settlements as a result of floods and the degradation of permafrost, raising the level of atmospheric air pollution in industrial cities and other consequences».

In work [10] it is predicted that «In 2050, only 58% of the world's population will have enough fresh water, and 24% will suffer from its lack. This will be a considerable «merit» of climate change».

Considerable attention is paid to the impact of climate change on water infrastructure. In [5] it is noted that «raising awareness of the consequences of long-term climate change, in particular for water security, with more frequent and extreme droughts means that more attention should be paid to different planning methods for creating sustainable water supply systems. Climatic factors, such as temperature, precipitation, snowfall and so on, have a significant impact on the state of water resources».

The World Health Organization (WHO) expresses its concern about the health of people in the context of climate change. It is said [11] that «Climate change is now recognized as one of the defining challenges of the 21st century, and protecting health from its impacts is an emerging priority for the public health community. Further, the potential range and magnitude of associated health risks should be central to the rationale for actions to mitigate the occurrence of climate change».

The analysis showed that taking into account climate change, more attention is paid to ensuring the reliability and protection of water supply and sewage systems. In terms of long-term investment decisions (dams, treatment facilities, pipelines), it is proposed to use a wider range of climate variability to avoid costly mistakes.

The domestic scientific press also addresses issues of climate change and the impact of this change on various aspects of the life of the Russian population, infrastructure systems, etc.

It is shown [12] that, «Given the data for 2016, the average annual temperature in the territory of the Russian Federation, it continues to grow more than 2.5 times faster than the global temperature, at a rate of 0.45°C per 10 years, and especially rapidly fast in the polar region, where the growth rate reaches 0.80°C per 10 years (Taimyr). However, the nature of warming is not the same in different seasons. The growth of spring precipitation continues, but summer precipitation in the southern half of the European part of Russia and in the Urals is decreasing … The level of CO2 concentrations in the surface layer of the atmosphere reached its new maximum in 2016 … In 2016, 590 cases of meteorological phenomena and complex adverse meteorological phenomena were registered. All these, as a rule, caused the most significant damage to the sectors of the economy and the private sector».

The influence of climate change on the safety of gas pipelines is estimated [13]: «In the anomalous zones of river basins of Russia, considered in the article, one should expect changes in the characteristics of the runoff. These characteristics will affect the sediment runoff parameters, as well as the load on the transitions of gas pipelines through water barriers, on deformation of banks and river beds and watercourse land, on the denudation of underwater gas pipelines».

In some regions, major changes are possible. It is reported in [14] that «In the Baikal region, modern and particularly predictable conditions favor climatic desertification».

If you turn to the Ural region, you can also note evidence of climate change. According to the Sverdlovsk hydrometeorological center [15] «during the period from 1960 to 2011, the trend of changes in the average annual temperature and precipitation values was revealed. Graphs of the temperature trend confirm the process of climate warming».

How can changes in climatic factors influence the stability and sustainability of the systems of water supply and sewage systems (WSSS)? According to information from municipal enterprise «Vodokanal» Ekaterinburg [16]: «the Low volume of flood 2017 (67% of meteorologists' forecast) did not allow to fill 100%the reservoir of Yekaterinburg. A small amount of rain made it impossible for the accumulation of water in the summer months. Today «Volchikhinskoe» reservoir is filled at 72%. To transfer the missing amount of water (25 million cubic meters) in «Volchikhinskoe», reservoir will be connected to the pumping water system from «Niazepetrovskoe» reservoir at a flow rate of 3.0 m3/s. Cost will be 35 million rubles per month. It is planned to pump for three months». Over the past decade, municipal enterprise «Vodokanal» had to resort to such transfer 8 times, indicating the influence of climatic factors on the operation of the water system.

The normal operation of infrastructure systems, in particular water supply and sewage systems, can be complicated in emergency situations that may occur when climate change occurs.

In general terms, the security and sustainability of WSSS are associated with the emergence of natural and man-made disasters and terrorist acts. Both water sources and individual elements of these systems can be affected: water intakes, water treatment facilities and wastewater treatment plants, pumping stations, storage tanks, pipelines, power supply and automation systems, installations for the preparation of reagents and chlorinator systems, laboratories, dispatch centers and etc. The greatest risk is associated with possible contamination of sources of drinking water with such substances, that can't be removed by water treatment stations which are not designed for that purpose. There may be a reduction of water resources in water sources or their redistribution through the territory, changing the parameters of the water source (the depth of the riverbed, its width, the speed of water movement etc.).

Measures to prevent accidents, disasters, terrorist acts and their elimination are prescribed in the relevant documents of the Ministry of Emergency Situations (MES) [17-19]. There are also requirements for creating backup sources of water supply for populated areas [20]. In the process, climate change situations may arise that are similar to extraordinary events, and differ from them in some parameters: the time of impact, its strength and depth. Nevertheless, it should be noted that these documents do not cover the whole range of situations that may be caused by climate disturbances. From this point of view, a serious analysis of the possible consequences and the development of specific regional measures for their prevention and elimination are needed.

A complex analysis of the effectiveness of the operation of the water supply and sewage systems was carried out based on "schemes of WSSS" of settlements and urban entities of the Sverdlovsk Region. The analysis showed the presence of many deviations from the normal functioning of these systems. It is necessary to carry out major repairs, reconstruction or replacement of equipment, modernization of existing technologies for water treatment and sewage treatment, equipment for sedimentation treatment. It requires strengthening the material base, as well as solving personnel issues, upgrading their skills in accordance with innovative solutions. It is clear that the presence of such shortcomings can be further exacerbated by phenomena related to the impact of climate change.

In this setting, it is necessary to consider the situation in which climate change and related impacts on water supply and sewage systems do not cease, but continue to move in a negative direction for these systems. At the same time, the WSSS systems must be improved in order to perform the functions assigned to them: maintaining the required water quality, supply and pressure, providing the required degree of wastewater treatment.

Such state of water supply and sewage systems really implies their constant development, i.e. the movement towards the use of innovative technologies for water treatment and wastewater treatment, the use of more modern equipment, the continuous growth of the skills of personnel.

In this way:

- Current negative trends in climate change should be considered as unfavorable factors for the sustainable functioning and development

of infrastructure facilities (for example, WSSS) in the Russian regions;
- reduction of greenhouse gas emissions and active adaptation to climate change, consisting in the adaptation of anthropogenic (man-made) and mixed systems to adverse changes, should be considered as the main directions for eliminating the negative factors of climate change;
- improving energy efficiency, using alternative energy sources, developing and implementing innovative technologies with zero or low carbon content will reduce the dependence of infrastructure systems on climate change.
- To ensure the sustainable development of regional infrastructure systems water supply and sewage systems in the context of climate change, the following tasks must be accomplished:
- to conduct qualitative and quantitative assessment of factors that may arise as a result of climate change and affect the operation of the systems;
- to assess economic, environmental and social implications of climate change for the region from the point of view of violation of the existing natural and man-made balance;
- to determine the reserves to ensure the stability and reliability of the systems in the face of climate change;
- create a regional database (legal, organizational, scientific aspects, etc.) that will provide reliable, safe and efficient operation of systems in the face of climate change;
- to carry out the examination and updating schemes water supply and sewage systems of settlements of the region;
- inform professionals and the public about the consequences that may arise in the process of climate change in the region, to develop practical adaptation measures to such changes and neutralization of negative phenomena;
- to introduce in educational programs of higher educational institutions questions about the readiness of infrastructure systems for work in conditions of climate change.

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